CLAIMS

1. A beam combiner apparatus, comprising:

a first beam displacer; and

a second beam displacer coupled to the first beam displacer through a wave plate and a Faraday Rotator, wherein the wave plate and the Faraday rotator rotate the polarization of an input light beam by equal amounts.

2. The beam combiner apparatus of claim 1, wherein the first beam displacer and the second beam displacer are composed of a birefringent crystal.

3. The beam combiner apparatus of claim 1, wherein the wave plate is a half-wave plate.

4. The beam combiner apparatus of claim 1, wherein the Faraday rotator includes a garnet stone.

5. The beam combiner apparatus of claim 1, wherein the wave plate is disposed between the first beam displacer and the Faraday rotator.

6. The beam combiner apparatus of claim 1, wherein the Faraday rotator is disposed between the first beam displacer and the wave plate.

7. The beam combiner apparatus of claim 1, wherein the wave plate includes a birefringent crystal.

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8. The beam combiner apparatus of claim 1, wherein both the wave plate and the Faraday rotator rotate the polarization of the input light beam in a first rotation direction when the input light beam is input from a first propagation direction, and wherein the wave plate and Faraday rotator rotate the polarization of the input light beam in a second opposite rotation direction when the input light beam is input from a second propagation direction, the second propagation direction being the reverse of the first propagation direction.

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9. A method of combining light beams, comprising:

displacing a second light beam towards a first light beam, said second light beam having a polarization orthogonal to the polarization of the first light beam and said second light beam being substantially parallel to said first light beam;

rotating the polarization of the first and second light beams by a same first amount in a first rotation direction;

rotating the polarization of the first and second light beams by the same first amount in a second opposite rotation direction; and

further displacing the second light beam towards the first light beam to form a combined light beam, said combined light beam being polarized along a first plane and second plane, said second plane being orthogonal to the first plane.

10. The method of claim 9, wherein a first beam displacer is used to displace the second light beam towards the first light beam.

11. The method of claim 9, wherein a wave plate is used to rotate the polarization of the first and second beams in the first rotation direction, and wherein a Faraday rotator is used to rotate the polarization of the first and second beams in the second opposite rotation direction.

12. The method of claim 9, further comprising:

using a second beam displacer to combine the first and second light beams.

13. The method of claim 9, wherein the first amount is about 45°.

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14. A method of optically isolating a combined light beam, comprising:

separating the combined light beam into a first beam and a second light beam, said combined light beam being polarized in two orthogonal planes, and said first light beam being polarized in a plane that is orthogonal to the polarization plane of the second light beam;

in a first operation, rotating the polarization of both the first and second light beams by a first amount in a first rotation direction;

in a second operation, rotating the polarization of both the first and second light beams by the first amount in the first rotation direction; and

displacing the first light beam towards the second light beam to form a re-combined beam, said re-combined light beam being polarized along a first plane and second plane, said second plane being orthogonal to said first plane.

15. The method of claim 14, further comprising:

transmitting the re-combined beam to a predetermined location other than the aperture of a lens.

16. The method of claim 14, wherein a second beam displacer is used to separate the combined light beam.

17. The method of claim 14, wherein a Faraday rotator is used to rotate the polarization of both the first and second light beams in the first operation.

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18. The method of claim 14, wherein a wave plate is used to rotate the polarization of both the first and second light beams in the second operation.

19. The method of claim 14, wherein a first beam displacer is used to displace the first light beam towards the second light beam.

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20. A beam combiner apparatus, comprising:

a first collimator having a first longitudinal axis;

a second collimator having a second longitudinal axis, said second longitudinal axis being parallel to said first longitudinal axis;

a first optical fiber coupled to the first collimator;

a second optical fiber coupled to the second collimator;

a first beam displacer that receives first and second light beams respectively transmitted from the first and second collimators and deflects the second light beam toward the first light beam;

a wave plate that receives and rotates a polarization of each of the first and second light beams transmitted from the first beam displacer;

a Faraday rotator that receives and rotates the polarization of each of the first and second light beams;

a second beam displacer that receives the first and second light beams from the Faraday rotator and combines the first and second light beams into a combined light beam; and

a third collimator that receives the combined light beam transmitted from the second beam displacer, the third collimator having a third optical fiber coupled to the third collimator to transmit the combined light beam.

21. The beam combiner apparatus of claim 20, wherein the first beam combiner, the second beam combiner, and the wave plate are composed of a birefringent material.

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22. The beam combiner apparatus of claim 20, wherein the Faraday rotator is a garnet stone.

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23. A beam combiner apparatus, comprising:

a first optical fiber coupled to a first lens that transmits a first polarized light beam along a path in a forward propagation direction;

a second optical fiber coupled to a second lens that transmits a second polarized light beam along a path in the forward propagation direction;

a first birefringent crystal that is positioned adjacent the first and second lenses and receives the first and second light beams, wherein the first birefringent crystal deflects the second light beam toward the first light beam and transmits the first and second light beams in the forward propagation direction;

a second birefringent crystal that is positioned to rotate the polarization of the first and second light beams received from the first birefringent crystal and to transmit the first and second light beams along the path in the forward propagation direction;

a garnet stone that is positioned to rotate the polarizations of the first and second light beams received from the second birefringent crystal and transmit the first and second light beams along the path in the forward propagation direction;

a third birefringent crystal that is positioned to combine the first and second light beams received from the garnet stone and transmit the combined light beam in the forward propagation direction; and

a third lens that is positioned adjacent the third birefringent crystal to transmit the combined light beam in the forward propagation into a third optical fiber, and wherein a third light beam transmitted through the third optical fiber along a path in a backward propagation direction is transmitted through the beam combiner apparatus such that the third light beam does not enter one of the first and second lens.

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24. The apparatus of claim 23, wherein the garnet stone is adjacent the first birefringent crystal, and the second birefringent is adjacent the third birefringent crystal.

25. The apparatus of claim 23, wherein the first light beam is polarized along a first plane and the second light beam is polarized along a second plane, said second plane being orthogonal to the first plane.

26. The apparatus of claim 23, wherein each of the first and second birefringent crystals has an optical axis of 45°.

27. The apparatus of claim 23, wherein the first and third birefringent crystals have the same optical axis.

28. The apparatus of claim 23, further comprising:

a plurality of pairs of lenses adjacent the first birefringent crystal; and

a plurality of lenses adjacent the third birefringent crystal wherein each lens adjacent the third birefringent crystal corresponds to a pair of lenses adjacent the first birefringent crystal.

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29. A method of combining first and second light beams, comprising:

collimating the first light beam polarized along a first plane with a first lens;

collimating the second light beam polarized along a second plane with a second lens, said second plane being orthogonal to said first plane;

by a first birefringent crystal, deflecting the second light beam toward the first light beam;

by a second birefringent crystal, rotating the polarization of the first and second light beams by a first angle in a first rotation direction;

by a garnet stone, rotating the polarization of the first and second light beams by the first angle in a second rotation direction that is opposite the first rotation direction;

by a third birefringent material, combining the second light beam with the first light beam; and

collimating the combined light beam with a third lens.

30. The method of claim 29, further comprising:

projecting the combined light beam into a third fiber, said combined light beam being polarized along two orthogonal planes.

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31. A method of optically isolating a beam of light, comprising:

projecting the beam of light, polarized along a first and second plane, into a third lens through a third fiber in a first propagation direction, said second plane being orthogonal to said first plane;

by a third birefringent crystal, splitting the beam of light into a first light beam polarized along the first plane and a second light beam polarized along a second plane, the first and second light beams propagating in the first propagation direction;

by a garnet stone, rotating the polarization of the first and second light beams by a first angle magnitude in a first rotation direction;

by a second birefringent crystal, rotating the polarization of the first and second light beams by the first angle magnitude in the first rotation direction; and

by a first birefringent crystal, re-combining the first and second light beams by diverting the first light beam toward the second light beam such that the re-combined light beam is not received by a first lens and is not received by a second lens.

32. The method of claim 31, wherein a third light beam polarized along a first plane is transmitted into the first lens and a fourth light beam polarized along a second plane is transmitted into the second lens along paths in a second propagation direction such that the third and fourth light beams are combined into a single light beam polarized along the first and second plane, said second plane being orthogonal to the first plane and said second propagation direction being opposite the first propagation direction.

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